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## PATENT SPECIFICATION



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**545,101**

Application Date (in United Kingdom): May 14, 1941. No. 6199,41.

Complete Specification Accepted: May 11, 1942.

### COMPLETE SPECIFICATION

#### Improvements in and relating to Coils for Dynamo-electric Machines

We, THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, a British Company, having its registered office at Crown House, Aldwych, London, W.C.2, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

10 Our invention relates to dynamo-electric machines and more particularly to the winding of alternating current dynamo-electric machines.

15 In large alternating current generators in which the windings which are disposed in the armature slots consist of conductors of considerable depth, the magnetic flux across the slots, due to the current in the conductors, gives rise to parasitic voltages 20 within the conductors which induce eddy currents therein. These currents, if of sufficient magnitude, may produce objectionable heating of the winding, and cause the material of the conductor to be ineffectively utilized.

25 In such a machine, where several conductors of a winding are arranged in an armature slot one above the other, the current carried by the bottom conductor of 30 the group has a flux path partly through the iron core and partly through the space between the side walls of the slot. The distribution of this flux for convenience may be regarded as uniform from the top 35 of the conductor to the mouth of the slot. Likewise, the flux due to current carried by the second conductor from the bottom may also be regarded as evenly distributed in the space between the slot walls from 40 the top of that conductor to the mouth of the slot, and similarly for the remaining conductors. The total voltage in each of the several conductors is made up of the voltage due to the flux of that conductor, 45 plus the voltage due to the flux of those of the conductors below the one in question. It will be seen, therefore, that this voltage varies in magnitude for each of the conductors, being greater for the conductor at the top. This variation in voltage of superimposed conductors of a winding tends to introduce parasitic currents 50 and it has been proposed to obviate this

objectionable feature by applying a twist in the end turns of a group of superimposed conductors, whereby the location of the conductors relative to the bottoms of the slots occupied by a winding are reversed from one slot to the other. 55

Our invention relates to an improved 60 arrangement of the end turns of a hairpin coil to accomplish the above-described transposition of the superimposed conductors whereby the enlarged section which would be had by applying a reversing 65 twist in the end turns is avoided, and whereby the required insulation of the end turns is facilitated.

Accordingly, the present invention resides in the provision of a preformed conductor coil for dynamo-electric machines comprising a plurality of flat strands, each bent edgewise into hairpin shape, the legs of the hairpin strands superimposed one on 70 the other in such a manner that the strand 75 which lies on the top of a group in one leg lies at the bottom of the group in the other leg, the strands crossing one another at the bend of the hairpin in such a manner that the surface of a strand which is at the 80 bottom in one leg also lies at the bottom in the other leg.

Our invention will be better understood from the following description taken in connection with the accompanying drawing. 85

On the drawings, similar reference characters represent the same parts throughout the several views and Fig. 1 is a view looking down on a portion of the 90 face of a dynamo-electric machine stator, showing a three-turn hairpin winding assembled in an adjacent pair of partially closed slots therein; Fig. 2 is a view at right angles to Fig. 1 taken on the line 95 A—A on Fig. 1, looking in the direction of the arrows; Fig. 3 is a cross-sectional view taken on the line B—B of Fig. 1; Fig. 4 is a view looking from the right hand end of Fig. 1; Fig. 5 is a view looking down on the bent end portion of one 100 three-conductor turn of the hairpin, showing the transposition of the conductors; Fig. 6 is a view partly in section taken on the line 6—6 of Fig. 5; Fig. 7 is an 105 end view looking from the left of Fig. 5.

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A fragment of the active face of the magnetic core of a dynamo-electric machine stator is represented by 1, and 3 represents a hairpin energizing coil 5 located in an adjacent pair of partially closed slots 5. The hairpin coil is built up from three superimposed conductors 7 and each conductor 7 is built up from three superimposed strands 9. Each strand 9 10 consists of a flat bar bent edgewise into the form of a hairpin. The complete hairpin coil is built up as indicated, with the strands 9 insulated from one another, and the conductors 7 insulated from one another in the customary manner. Suitable overall insulation is applied to the hairpin and it is inserted in the pair of adjacent slots 5 by pushing the legs of the hairpin through the slot endwise. Conducting clips 11 connect the ends of the conductors 7, as indicated in Fig. 4, whereby the hairpin is connected up to form a three-turn coil.

The three strands of each hairpin conductor 7 are transposed whereby the strand which is nearest the bottom of one slot is the strand farthest away from the bottom of the other slot. In Figs. 3, 5, 6 and 7 the three strands 9 have been identified by reference characters *a*, *b* and *c*, and it will be observed that top strand *a* in one slot becomes the bottom strand of the same conductor in the other slot. Referring to Figs. 5, 6 and 7, particularly, it will be seen that strand *b*, the middle strand of the three, extends outwardly from the body of the stator to a greater extent than strand *c*, so that with a slight bend flatwise of the strand, one leg of strand *b* can be placed over the corresponding leg of strand *c*, and the other leg of strand *b* can be placed underneath the corresponding leg of strand *c*. Strand *a* extends farther from the body of the stator than both strands *c* and *b*, so that one leg of *a* lies on top of strands *b* and *c*, and, due to a slight bend flatwise, the other leg of strand *a* lies underneath the other leg of strands *b* and *c*. It will be observed that the individual strands themselves are not twisted, that is, the bottom of strand *a* in one slot remains the bottom of strand *a* in the other slot. It will be seen that the transposition of the three strands of the conductors is obtained without applying a twist in the conductors, and without increasing the thickness of the coil at the

bend in the radial direction, that is, in the direction of the slot depth. The flat joint thus obtained facilitates the application of the insulation required, without making a bulky joint transversely. The transposition is also obtained with the introduction of less pronounced cavities than would be the case if the conductors were twisted, thus facilitating the insulation of the coil. A minimum of sharp corners compared to those which would exist if the coil was twisted, is obtained, thus further minimizing insulation difficulties.

While we have shown and described in detail a specific embodiment of our invention for the purpose of illustrating our invention, it will be understood that many modifications may be made. It will be understood that our invention may be applied to other windings. We have shown and described our hairpin coil as applied in a pair of adjacent slots in a stator. It will be obvious that it is not limited in this respect. It will also be obvious that our method of transposition of the strands is applicable to conductors having two or more strands and if it is desired each strand could be subdivided transversely of the slot to facilitate bending.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

1. A preformed conductor coil for dynamo-electric machines comprising a plurality of flat strands, each bent edgewise into hairpin shape, the legs of the hairpin strands superimposed one on the other in such a manner that the strand which lies on the top of a group in one leg lies at the bottom of the group in the other leg, the strands crossing one another at the bend of the hairpin in such a manner that the surface of a strand which is at the bottom in one leg also lies at the bottom in the other leg.

2. A preformed stator coil for a dynamo-electric machine, constructed and arranged substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 29th day of April, 1941.

A. S. CACHEMAILLE.

Crown House,  
Aldwych, London, W.C.2,  
Agent for the Applicants.

*(This Drawing is a reproduction of the Original on a reduced scale.)*

FIG. 1

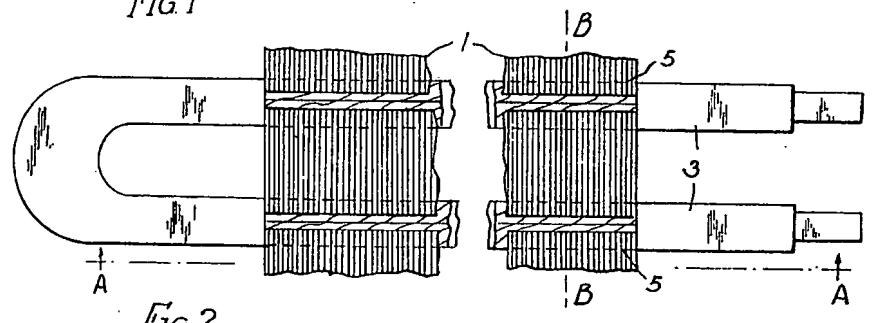


FIG. 2

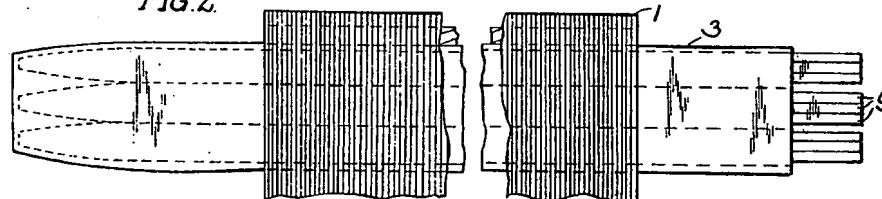


FIG. 3

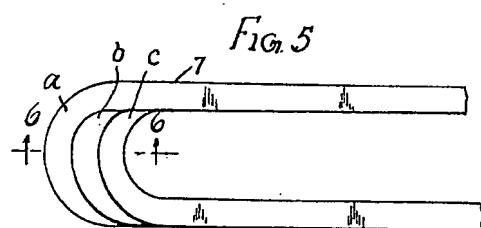
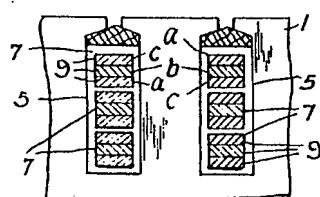


FIG. 4

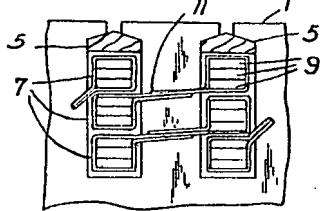


FIG. 7

